no particular note is produced for a whole second, and, therefore, not perceived for a whole second.

But, on the other hand, it is clear that we can listen to a high-pitched note for a second or for a minute or for any length of time. When we are hearing a note of 20,000 d.v. per second pitch, we are almost certainly *not* receiving 20,000 impulses per second into the central nervous system. To take an analogy from vision: when we perceive red light, we are certainly not receiving anything like (395×10^{12}) impulses per second, which is the "pitch" of red light. If, in seeing coloured light, such an enormous number of vibrations in the æther affect the retina, there must be something of a very different character as regards frequency, which, ascending the optic nerve, so stimulates the visual centre that we see coloured light.

We have in perceptual consciousness qualitative differences corresponding with objective quantitative differences, an ever-present problem of psycho-physics; and no one has ever suggested that our optic nerves and visual centres are dealing with impulses at many millions a second. Why, then, may we not apply the same reasoning to the ear?

When we are listening to all possible tones from, say, 1000 d.v. per second pitch to 40,000, may we not somehow have in consciousness qualitative differences corresponding with objective quantitative (arithmetical) differences? We cannot, apparently, be more definite than this.

In the case of the eye there is no conceivable possibility of an identity between the rhythm of optic-nerve impulses and that of the vibrations of the æther; is it not by analogy probable that neither is there any direct correspondence between the auditory nerve-impulses and the periodicity of sonorous vibrations?

D. FRASER HARRIS.

Dalhousie University, Halifax, N.S.,
November 29, 1918.

A Mistaken Butterfly.

THOUGH I cannot claim any special knowledge of insect behaviour, I hope you will allow me to make a few remarks on "A Mistaken Butterfly" discussed in NATURE for September 5 and December 12, 1918. I have my doubts as to whether it was the butterflies or the observers who were mistaken. A butterfly does not always alight on a flower, or on what it supposes to be one, but appears frequently to alight for rest. Now, in selecting a resting-place, it will naturally select a good "taking-off" position, and the knob of a hatpin and a golf ball are evidently from the butterfly's point of view good "taking-off" positions, especially the golf ball, it being surrounded by no good "taking-off" places, and its whiteness would help to direct attention to it.

A number of years ago I met two keen entomologists in Italy who were disappointed in not succeeding in capturing a butterfly they particularly wanted, though they had seen a number, but failed to net them. As I knew where that particular butterfly was likely to be found, I took my walk in that direction the following day, and on returning presented my friends with two specimens of the butterfly. These were captured without a net, by what I imagine is a well-known method. When the butterfly alighted I approached it from behind, keeping as well out of the range of its eyes as possible, and moving *very slowly*. When within arm's reach the hand was slowly stretched out, keeping it as low as possible and behind the insect. When the stalking is carefully done a capture is generally made, and the wings, before lifting it, may be folded to prevent their upper surfaces being damaged by contact with the fingers.

Now in the case of the two butterflies referred to, one was picked off a leaf of a bush, and the other had settled on my shoulder. I do not think they are so easily picked up if they have settled on flowers, as they are there on business, and are restless and away whenever they have accomplished their object.

JOHN AITKEN.

Ardenlea, Falkirk, December 17.

THE FUTURE OF BRITISH MINERAL RESOURCES.

NOW that the activities of a number of Government Departments, which were called into existence by the exigencies of the war, are happily likely to be nearing their end, we may hope to see the reports of their work given to the public; it is to be desired that a mass of valuable information, accumulated often at vast expense, should not be relegated to the limbo of a cobwebbed official pigeon-hole, but should be made generally available. It is scarcely to be expected that many of these reports will be as valuable as that lately issued by the Controller of the Department for the Development of Mineral Resources in the United Kingdom (Cd. 9184, price 6*d.* net), seeing that Sir Lionel Phillips was one of the rare exceptions amongst the small army of Controllers appointed by the Government, inasmuch as he had a thorough acquaintance with his subject before he assumed control; perhaps also that is why he did not hold his office for very long. It is characteristic of the attitude of the Ministry of Munitions towards a courageous and capable official under it, that the Minister takes special care to state that he accepts no responsibility for the opinions and conclusions contained in this report.

The report consists first of a summary of the conclusions arrived at by the Controller, and then of a part divided into two sections, dealing with statistics of production and the inferences to be drawn therefrom. For the numerous valuable tables contained in this report the original must necessarily be consulted, but some of the conclusions of Sir Lionel Phillips deserve both study and comment. He shows clearly that the native British production of non-ferrous metals falls far short of our requirements in normal times, as follows:—

	Production. Tons	Consumption. Tons
Lead	17,000 ...	179,000
Tin...	5,139 ...	21,000
Zinc	4,797 ...	185,000
Copper	139 ...	130,000

The tendency of the report is to show that no very great improvement in output is to be expected, except perhaps in a few isolated instances; it is shown that the output of non-ferrous metals has been falling off continuously for the last sixty years. The main causes assigned for this fact are the impoverishment or exhaustion of the deposits, and the increased costs of ore extraction and of pumping on one hand, and fall in value of metal on the other. Sir Lionel Phillips also lays stress

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upon the mismanagement of many mines, the unbusinesslike methods employed, and the lack of co-operation and combination amongst mine-owners. He further directs attention to another drawback, of which all engaged in the management of metal mines in this country are only too well aware, in the following words:—"Labour in the non-ferrous mines has in the past been paid on rather a low level, the wages have been, moreover, in many cases the reward for part-time service, many employees having small farms of their own or being habituated to dual occupations. The system is utterly pernicious, and involves great waste of the men's time and energy in going to and from the scenes of respective work, and entails poor efficiency all round. It has endured from time immemorial, and any change that may be brought about now can only be very gradually effected."

This criticism upon the labour conditions is perfectly sound, and will be endorsed by everyone who knows the system of working, especially in our lead and zinc mines. It is evident that with impoverished deposits, poor management, and inefficient labour the outlook for the non-ferrous metal-mining industry is not a very bright one. There are, however, a number of other difficulties to be contended with; perhaps the most serious is the question of taxation. It is clearly pointed out that "mines are, at best, wasting assets," and that "in all mines earning profits the amounts distributed to proprietors as dividends or profits consist not only of income, but include the return of capital as well. . . . To tax mining profits on this basis is to tax capital as well as income, and to differentiate unfairly against persons who invest in mines." Furthermore, the present system of taxation discourages the formation of a reserve fund to meet the inevitable fluctuations of mining, and as the report says: "Reserve funds so derived should not be taxed. Similarly, the tax-gatherer should not levy toll upon sums spent out of profits in development." Sir Lionel Phillips does not go on to draw the inevitable inference that the unhappy state of the metal-mining industry has to a large extent been brought about by this injudicious system of taxation; it is, however, clear enough that the discouragement of development must tend to leave mines impoverished or exhausted, since it prevents the discovery of new deposits or shoots of ore. It is hopeless to expect a sound policy of management when the accumulation of a reserve fund, which should form the basis of such a policy, is mulcted in taxes. Sir Lionel Phillips does not think that compulsion could be applied to force mining companies to set aside each year out of profits sums estimated as sufficient to redeem their capital; in France, however, the building up of a "legal reserve" is obligatory, and the system appears to work quite satisfactorily.

There is very much in this report that will repay careful perusal, and stress may well be laid upon the recommendations which urge the formation of a Mines Department for the United Kingdom, this Department having for its object the study and encouragement of the home mineral industry. The report is careful to point out that nothing more than advice and assistance is required from a Government Department; as the Controller says: "That there has been too little interference by Government in the past will be generally admitted. That there can well be too much interference is equally obvious. . . . Government cannot, I believe, undertake any industrial work as efficiently as individuals whose material well-being depends upon the result. The nationalisation of mines would, therefore, be disadvantageous to the country. . . . In most industrial enterprises, and certainly in mines, there is an element of hazard which fortune-seekers are willing and are bound to take, but which the Government ought not to, and permanent officials never would, take." There is no doubt that these opinions would receive the unanimous endorsement of all mining engineers experienced in the direction of British mining enterprises, and it is to be hoped that the Government of the country will give heed to the findings of the Controller of this important Department of national industry.

H. LOUIS.

SUPERSATURATION AND TURBINE THEORY.[1]

IT has become of late years increasingly obvious that the equilibrium state of saturation, assumed as the basis of the theory of the steam-engine, does not apply accurately to the case of rapid expansion, especially in turbines. Steam in rapid expansion does not even begin to condense until its temperature has fallen far below the saturation limit. This fact has been familiar for many years as a general property of vapours called supersaturation, but it was not realised until recently that it might produce effects which could not be ignored in practice. Many authorities (*e.g.* Prof. Rateau, "Flow of Steam," 1905) held that there was no appreciable retard in the condensation even in a steam-nozzle where the expansion reaches the limit of rapidity. On the other hand, Callendar and Nicolson (Proc. Inst. C.E., 1897) found experimental evidence of supersaturation in the cylinder of a reciprocating engine at comparatively low speeds. Assuming that the adiabatic of supersaturated steam was simply a continuation of that of superheated steam, they calculated that a loss of 20 per cent. of available heat-drop would result at low pressures if there were no condensation; but as there was known to be a limit to the state of supersaturation they estimated that the actual loss due to this cause would not exceed 5 per cent. to 10 per cent. in practice, depending on the range and rapidity of expansion.

The first definite measurement of the supersaturation limit was obtained by Mr. C. T. R. Wilson (Phil. Trans. R.S., 1897) by expanding water vapour mixed with air at 20° C. It was found that the mixture could be expanded in the absence of dust or other nuclei without any con-

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[1] "A New Theory of the Steam Turbine." By Harold Medway Martin. Reprinted from *Engineering*, vol. cvi. Pp. 22+folding diagram.

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